(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 693 695 B1

B J

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
01.03.2000 Bulletin 2000/09

(51) Int. Cl.7: **G01S 13/02**

(21) Application number: **94108006.1**

(22) Date of filing: **24.05.1994**

(54) **Dual standard radio frequency identification system**

Zwei-Normen Identifizierungssystem mit Funkfrequenzen

Système d'identification bi-standard à fréquence radio

(84) Designated Contracting States:
DE FR GB IT NL

(43) Date of publication of application:
24.01.1996 Bulletin 1996/04

(73) Proprietor:
TEXAS INSTRUMENTS DEUTSCHLAND GMBH
85356 Freising (DE)

(72) Inventor: **Schuermann, Josef**
85416 Langenbach (DE)

(74) Representative:
Schwepfinger, Karl-Heinz, Dipl.-Ing.
Prinz & Partner GbR
Manzingerweg 7
81241 München (DE)

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- **PATENT ABSTRACTS OF JAPAN vol. 4, no. 168 (P-037) 20 November 1980 & JP-A-55 114 975 (JAPANESE NATIONAL RAILWAYS) 4 September 1980**
- **PATENT ABSTRACTS OF JAPAN vol. 4, no. 168 (P-037) 20 November 1980 & JP-A-55 114 974 (JAPANESE NATIONAL RAILWAYS) 4 September 1980**

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Printed by Xerox (UK) Business Services
2.16.7/3.6

Description

FIELD OF THE INVENTION

[0001] This invention relates to a dual standard RF-ID system as defined in the precharacterizing portion of claim 1.

BACKGROUND OF THE INVENTION

[0002] A system as defined in the beginning is known from US-A-5 235 326. This system is a multi-mode identification system which consists of readers and tags wherein a reader in the proximity of and inductively coupled to a tag may interrogate and obtain a response from the tag in accordance with a specified process if the tag belongs to a certain class of tags. Communication between tag and reader is accomplished by a reader establishing a reversing magnetic field in the vicinity of a tag and the tag varying its absorption of power from the field in accordance with the information to be transmitted. The reader detects these variations in power absorption and extracts from these variations the information transmitted by the tag. The reader can read tags which transmit information by causing the voltage across a reader coil to vary in phase and/or frequency as well as amplitude. The reader can be configured to operate in a variety of modes by means of hardware and firmware switches actuated by mode control data contained in a read-only memory within the reader.

[0003] Many different communication protocols are used in remote RF identification systems today. Some systems use a full duplex communication protocol wherein the interrogator is continuously transmitting an interrogation signal while the transponder in the field is responding. One advantage of this system is that the transponder can be receiving power from the interrogator continuously while it is transmitting its response signal. One variation of the full duplex system uses amplitude modulation where the data return signal of the transponder is similar in frequency to the frequency of the interrogation signal. Another variation uses frequency or phase modulation and data return signals are more different in frequency than the interrogation signal compared to the amplitude modulation case.

[0004] Other RF-ID systems use a half-duplex communication protocol wherein the interrogator transmits a powering interrogation signal for a predetermined amount of time and then stops transmitting and listens for a transponder response signal for a predetermined amount of time. Two advantages of this system are that the powering and data transmission phase can be independently optimized and that the interrogation and response signal frequencies can be the same because either the interrogator or the transponder will be transmitting at any given moment, not both. Other advantages are that the transponder signals are stronger and the efficiency is higher which results in less power consumed in the transponder while the interrogation distance is larger. One disadvantage of these system is that the transponder requires an energy storage device.

[0005] A need has arisen for an RF-ID system communication protocol such that one reader, i.e. interrogator, is operable to receive a plurality of transponders response signals, wherein the transponders are operating under different communication protocols, such as full-duplex and half duplex communication protocols. Optimally, the protocol and reader must meet these demands using a frequency protocol for half and full duplex functions with at least amount of additional components and with a minimum loss of demodulation speed performance.

SUMMARY OF THE INVENTION

[0006] An object of the invention is to provide a reader which can read transponders having different communication standard protocols, such as full-duplex and half-duplex communication protocols, with a minimum loss of demodulation speed performance and with the least amount of additional components.

[0007] According to one aspect of the present invention, there is provided a dual standard RF-ID protocol system, as mentioned in the beginning and comprising the features defined in the characterizing portion of claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] In the drawings:

FIG. 1 is a schematic diagram of a reader in a dual standard RF-ID system according to a preferred embodiment of the invention while the reader is transmitting.

FIG. 2 is a schematic diagram of a receiver in a dual standard HDX/FDX-FSK RF-ID system according to a preferred embodiment of the invention while the reader is receiving in Heterodyne mode.

FIG. 2a is an embodiment of a Reader in a multi-standard version to receive HDX(FSK) and FDX(ASK and FSK) signals with a HDX/FDX in Heterodyne mode.

FIG. 2b is an embodiment of a Reader in a multi-standard version to receive HDX(FSK) and FDX(FSK) in a Heterodyne mode and FDX(ASK) in homodyne mode.

FIG. 3 is a timing diagram of several components in the reader during the full and half-duplex cycles that the reader operates within.

FIG. 4 is a spectrum analysis of the transmitted and received RF signals.

FIG. 5 is a spectrum analysis of the transmitted and received IF signals.

[0009] Corresponding numerals and symbols in the

different figures refer to corresponding parts unless otherwise indicated.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0010] The half-duplex (HDX) and full duplex (FDX) transponders are tuned to and respond to 134.2KHz. Full duplex transponders do not generate a response signal of their own but use the interrogation signal directly for powering. The full duplex transponders begin transmitting the identification code response signals back to the interrogator instantaneously. The half-duplex transponders will only charge-up during the exciter signal and then when the exciter signal has terminated, the half-duplex transponders will transmit their own FSK modulated identification code response signals.

[0011] In a more detailed description of one embodiment of the invention, the interrogator transmits an interrogation signal or exciter power signal of 134.2 KHz to power up the transponders. Those components of the interrogator that are necessary for the transmission of the interrogation signal are shown schematically in Figure 1. The control input triggers RF source **18** to produce a 134.2KHz signal. The 134.2KHz signal is amplified by amplifier **16** and resonates the antenna resonant circuit comprised of capacitor **12** and coil **10**. The 134.2KHz signal is transmitted via antenna coil **10**. If the resonant circuit **10,12** has a high "Q", upon termination of the exciter signal, the switch **14** is closed damping the exciter signal to immediately stop transmission of the exciter signal. If the resonant circuit **10,12** has a low "Q", the exciter signal will not have to be damped, therefore switch **14** will not have to be closed.

[0012] Those components of the interrogator that are necessary for the reception of the response signals are shown schematically in Figure 2. The FIG. 2 reader receiver section is able to simultaneously receive the half-duplex frequency shift-keying HDX(FSK) as well as the full-duplex frequency shift-keying FDX(FSK) type transponder identification code response signals. The reception antenna resonant circuit **13** comprises the similar parallel elements of coil **10** and capacitor **12** as the transmission antenna resonant circuit did, but includes a resistor **11** in parallel also. Resistor **11** provides the damping action to the antenna resonant circuit that is necessary to provide a wide bandwidth for the wide range of frequencies to be received. As previously mentioned, first the FDX(FSK) transponder sends it's response signals immediately upon receiving the exciter signal. The FDX(FSK) transponder response signals are received on antenna **10,12** and applied to the input of mixer **26**. Upon reception of the FDX(FSK) modulated signal frequencies at the RF port of mixer circuit **26**, the carrier signal frequency of 134.2KHz is also evident at the RF port of mixer circuit **26**, but at a much higher power level than the FSK modulated signal frequencies. Therefore, in order to not obliterate the FSK signals, a trap circuit **22** can be placed in betweeen the antenna resonant circuit **15** and the mixer circuit **26** to reduce the amplitude of the carrier signal frequency 134.2KHz to a level that is more comparable to the amplitude level of the (FDX)FSK response signal frequencies. The trap circuit **22** is enabled during transmission of the exciter signal via switch **24** which is controlled through the same controller (not shown) that operates the exciter signal generator of Figure **1**. The FDX(FSK) response signal is then heterodyned down to the IF frequency of 21.8KHz via mixer circuit **26** which mixes the excitation signal (functioning as L.O.) and the sideband transponder signals (approximately 136 and 132 KHz). The LO port (source **28**) of mixer **26** lies fallow during the full duplex portion of the RF-ID sequence. The IF frequencies are selectively band filtered out of the range of frequencies coming from the output of mixer circuit **26** by the selective either bandpass or lowpass filter **30**. The band filtered signals are then selectively amplified by the signal log-detect circuit **32**. The selective amplifier circuit **32** not only amplify the baseband frequency signals post filtering, but can also provide a carrier signal detect output. The signal detect output facilitates an adaptive receiver in which upon the absence of a signal being received, the controller can institute much shorter powering pulse durations from the exciter **18**. In this way, the RF-ID sequence duration is minimized with maximum efficiency. Those amplified signals are then amplitude limited by the limiter/comparator circuit **34** followed by the FSK Demodulator **58.** A possible configuration for a demodulator **58** and it's operation follows. A zero detector circuit **36** combined with a timer circuit **38** performs the function of demodulating the baseband signals to determine which bit, respectively the low or high bit FSK frequency, is being sent. According to a preferred embodiment of the invention, an easily integratable ASIC type receiver can be used to perform the demodulation. The demodulation can be performed by determining the number of zero crossings in a given time duration via circuit **36** wherein the timer circuit **38** provides the time base reference. The amount of time elapsed between one zero crossing to another zero crossing will be different for different frequencies, i.e. 124.2 KHz and 134.2 KHz, and therefore the number of zero crossings in the same amount of time will be different for different frequencies. From the output of circuit **36** comes a train of pulses of constant width and various periods, depending upon how many zero crossings were detected, which subsequently gets shaped by a monoflop into a well defined pulse. This well defined pulse is then integrated through an integrator which yields different D.C. levels. A Schmidtt Trigger can be used to distinguish between the two D.C. levels and yield either the high or low FSK bit.

[0013] Upon the signal-log detector detecting the absence of the FDX(FSK) signal, the receiver is ready to receive the HDX(FSK) transponder signal when

switch **18** is triggered to close in order to heterodyne the HDX(FSK) signal down to the same IF frequency (21.8 KHz) as the FDX(FSK) signal by activating LO source **28**. During the entire duration that the exciter frequency is being transmitted, the, half-duplex transponders are charging up, preparing to respond. The half-duplex transponders respond in response to the termination of the exciter pulse. In addition, the controller has predetermined the exciter duration to correspond with a charge-up of the half-duplex transponders. Therefore, at the end of the exciter duration, the controller closes the delay control switch **24** shown in Figure 1, such that any residual resonance of the antenna resonant circuit **13** is greatly damped. The significant drop in power level of the exciter signal is detected by the half-duplex (HD) transponders. The Full Duplex (FD) transponders cease responding and the HD transponders, on the other hand, can start responding. The HDX(FSK) transponders, store the energy received from the exciter signal to power the generation of a new carrier signal at the same frequency of the exciter signal, i.e. 134.2KHz. In addition, a second FSK frequency is generated, i.e. 124.2KHz such that the transponder identification code is FSK modulated between 134.2KHz and 124.2KHz. The HDX(FSK) transponders begin transmitting the FSK modulated response signals almost immediately following the termination of the exciter signal. The HDX(FSK) response signal is received by antenna circuit **10,12** and heterodyned down to 21.8 KHz via mixer **26** which mixes the transponder frequency of 129.2 KHz with LO source **28** of 151 KHz. The baseband signal is then filtered through filter **30** and demodulated through demodulator **58** as previously described. Switches **52** and **54** of the Biphase to NRZ decoder and Non-return-to-zero paths, switch from the Biphase to NRZ decoder path to the Non-return-to-Zero path upon the termination of the exciter signal which allows the HD data signals to pass straight through the NRZ path to the data output port. This transistion must occur because most of the full-duplex systems use a biphase encoded data signal which has to be decoded via a Biphase to NRZ decoder by the receiver.

[0014] Figure 2a reader embodiment is operable to receive HDX(FSK) as well as FDX(ASK) and FDX(FSK) transponder signals. Assuming an FDX(FSK) or HD(FSK) signal is received, the receiver functions as described in FIG. 2. In the case of an absence of an FDX(FSK) signal and the presence of an FDX(ASK) signal, the signal log-detect signal from circuit **32** is missing because no FSK signal is received. The absence of the FSK signal activates the LO 156 KHz switch **19** which causes 156 KHz to be mixed with the exciter signal frequency of 134.2 KHz and heterodynes the FDX/ASK signal down to 21.8 KHz. The same control signal which closes switch **19** to activate the 156 KHz LO, closes switch **24** thereby activating a notch filter **22** at midband 134.2 KHz to reduce the excitation signal and allow the amplitude/log ASK detector to operate and demodulate the ASK signal which is connected to the data output terminal. Alternatively or in parallel, a notch filter can be inserted at the output of the mixer to notch out midband 21.8 KHz. If the signals are biphase or e.g. Manchester encoded, an NRZ to biphase decoder circuit **40** can be inserted into the data path. Otherwise the NRZ data passes straight through via the NRZ path as shown in Figure 2a.

[0015] The Figure 2b shows another reader embodiment combining HDX(FSK), FDX(ASK) and FDX(FSK) reception. The HDX(FSK) and FDX(FSK) functions as described in Figure 2. The FDX(ASK) demodulation operates as follows. The transponder signal, (sidebands of 134.2KHz), is received on antenna circuit **10,12**, and, in addition to the exciter signal 134.2KHz, is fed into the RF input of mixer-demodulator **21** and is homodyned down to baseband. Mixer **21** functions as a baseband demodulator in this case, wherein the signal-log detect circuit upon detecting the presence and absence of the signal, is actually demodulating the ASK modulated signal. The demodulated signal is followed by a baseband lowpass or bandpass filter and amplifier. After demodulation the FDX(ASK) data signals are passed through a circuit **40** which can change a bi-phase modulation encoded data signal, e.g. Manchester signal, from biphase to a Non-Return-To-Zero (NRZ) binary signal. Once the signals are in Non-Return-to-Zero (NRZ) format, they can be supplied to the logic.

Claims

1. A dual standard RF-ID protocol system, which can receive and recognize first, second and third transponders comprising:

    a first antenna circuit (13) for transmitting an excitation pulse to initiate full duplex transponders to respond;
    characterized in that the excitation pulse transmitted by the first antenna circuit (13) also serves to charge-up half duplex transponders;
    and in that the system further comprises
    a second antenna circuit (15) for receiving a transponders RF frequency response signal;
    a mixer circuit (26, 21) which mixes the transponder RF frequency signal with one LO frequency signal and yields a predetermined IF frequency signal;
    an amplifier circuit (32) for amplifying said IF frequency signal and comprising a signal-detect circuit which detects the presence or absence of a first transponder type signal being received;
    an amplitude limiting circuit (34) for amplitude limiting said IF frequency signal; and
    a demodulator circuit for demodulation of said IF frequency signal into a train of pulses having different amplitudes and constant width com-

prising;

a zero detector circuit (36) for detecting the number of zero crossings in a predetermined amount of time,
a timer (38) for defining said predetermined time for said zero detector circuit (36), and
wherein said amplitude of said pulses is dependent upon said number of detected zero crossings.

2. The system of claim 1 or claim 2, wherein said first, second and third transponders are respectively FDX(FSX), HDX(FSX) and FDX(ASK) transponders.

3. The system of claim 1 or claim 2, wherein said demodulator circuit further comprises:

a monoflop for shaping said pulses into well defined pulses;
an integrator for integrating said well-defined pulses and for transforming said pulses into two different D.C. levels; and
a Schmidtt Trigger circuit for distinguishing between said two D.C. levels and yielding either a high or low bit.

4. The system of any preceding claim, wherein upon receiving a third transponder signal, said signal-detect circuit (32) detects the absence of said third signal and thereby triggers activation of another LO frequency signal such that the resulting IF frequency remains the same predetermined IF frequency.

Patentansprüche

1. Duplexsystem mit Standard-HF-Kennungsprotokoll, das Transponder erster, zweiter und dritter Art empfangen und erkennen kann, mit

einer ersten Antennenschaltung (13), die dazu dient, einen Anregungsimpuls auszusenden, um das Antworten von Duplex-Transpondern auszulösen;
dadurch gekennzeichnet, daß der durch die erste Antennenschaltung (13) übertragene Anregungsimpuls auch dazu dient, Halbduplex-Transponder aufzuladen; und daß das System darüber hinaus
eine zweite Antennenschaltung (15) zum Empfangen eines HF-Antwortsignals der Transponder;
eine Mischerschaltung (26, 21), die das HF-Transpondersignal mit einem LO-Frequenzsignal mischt und ein Signal mit einer vorherbestimmten Zwischenfrequenz liefert;
eine Verstärkerschaltung (32), die dazu dient, das Zwischenfrequenzsignal zu verstärken und eine Signalerkennungsschaltung umfaßt, die das Vorhandensein oder das Nichtvorhandensein eines empfangenen Signals von einem Transponder des ersten Typs erkennt;
eine Amplitudenbegrenzungsschaltung (34), die dazu dient, die Amplitude des Zwischenfrequenzsignals zu begrenzen; und
eine Demodulatorschaltung zur Demodulation des Zwischenfrequenzsignals in eine Folge von Impulsen mit unterschiedlichen Amplituden und einer konstanten Dauer umfaßt, die
eine Nulldetektorschaltung (36) zum Erkennen der Anzahl an Nulldurchgängen in einer vorherbestimmten Zeitdauer und einen Zeitgeber (38) umfaßt, der dazu dient, eine vorherbestimmte Zeitdauer für die Nulldetektorschaltung (36) zu definieren, und
bei der die Amplitude der Impulse von der Anzahl der erkannten Nulldurchgänge abhängt.

2. System nach Anspruch 1 oder Anspruch 2, bei dem die Transponder der ersten, zweiten und dritten Art FDX(FSK)-, HDX(FSX)- bzw. FDX(ASK)-Transponder sind.

3. System nach Anspruch 1 oder Anspruch 2, bei dem die Demodulatorschaltung darüber hinaus

eine monostabile Kippstufe, die dazu dient, die Impluse in eine passende definierte Form zu bringen;
einen Integrator, der dazu dient, die passend definierten Impulse zu integrieren und in zwei unterschiedliche Gleichspannungspegel umzusetzen; und
eine Schmitt-Trigger-Schaltung umfaßt, die dazu dient, zwischen den zwei Gleichspannungspegeln zu unterscheiden und entweder ein H- oder ein L-Bit zu liefern.

4. System nach einem der vorhergehenden Ansprüche, bei dem beim Empfangen eines dritten Transpondersignals die Signalerkennungsschaltung (32) die Abwesenheit des dritten Signals erkennt und dadurch die Aktivierung eines weiteren LO-Frequenzsignals auslöst, so daß die sich ergebende Zwischenfrequenz auf der vorherbestimmten Zwischenfrequenz bleibt.

Revendications

1. Système de protocole bi-standard RF-ID, qui peut recevoir et reconnaître des premier, deuxième et troisième transpondeurs comprenant:

un premier circuit d'antenne (13) pour trans-

mettre une impulsion d'excitation afin de provoquer une réponse de transpondeurs de type duplex intégral ;

caractérisé en ce que l'impulsion d'excitation transmise par le premier circuit d'antenne (13) sert aussi à charger des transpondeurs de type simplex ; et en ce que le système comprend en outre

un deuxième circuit d'antenne (15) destiné à recevoir un signal de fréquence RF de réponse de transpondeurs ;

un circuit mélangeur (26, 21) qui mélange le signal à fréquence RF du transpondeur avec un signal de fréquence LO et fournit un signal à fréquence IF prédéterminé;

un circuit amplificateur (32) pour amplifier ledit signal à fréquence IF et comprenant un circuit détecteur de signal qui détecte la présence ou l'absence d'un signal reçu d'un premier type de transpondeur ;

un circuit limiteur d'amplitude (34) pour limiter l'amplitude dudit signal à fréquence IF ; et

un circuit démodulateur pour la démodulation dudit signal à fréquence IF en un train d'impulsions ayant différentes amplitudes et de largeur constante comprenant :

un circuit détecteur de zéro (36) pour détecter le nombre de passages à zéro pendant une période de temps prédéterminée,

une horloge (38) pour définir ladite période de temps prédéterminée pour ledit circuit détecteur de zéro (36), et

dans lequel ladite amplitude desdites impulsions est fonction dudit nombre de passages à zéro détectés.

2. Système selon la revendication 1 ou 2, dans lequel lesdits premier, second et troisième transpondeurs sont respectivement des transpondeurs FDX (FSK), HDX (FSX) et FDX (ASK).

3. Système selon la revendication 1 ou 2, dans lequel ledit circuit démodulateur comprend en outre :

un monovibrateur pour mettre en forme lesdites impulsions en des impulsions bien définies ;

un intégrateur pour intégrer lesdites impulsions bien définies et pour transformer lesdites impulsions en deux niveaux D.C. différents ; et

un circuit de déclenchement de Schmidt pour faire la distinction entre lesdits deux niveaux D.C. et fournir soit un bit de niveau élevé soit un bit de niveau faible.

4. Système selon l'une quelconque des revendications précédentes, dans lequel lors de la réception d'un signal du troisième transpondeur, ledit circuit détecteur de signal (32) détecte l'absence dudit troisième signal et par conséquent déclenche l'activation d'un autre signal à fréquence LO de telle sorte que la fréquence IF résultante reste la même fréquence IF prédéterminée.

Fig. 1

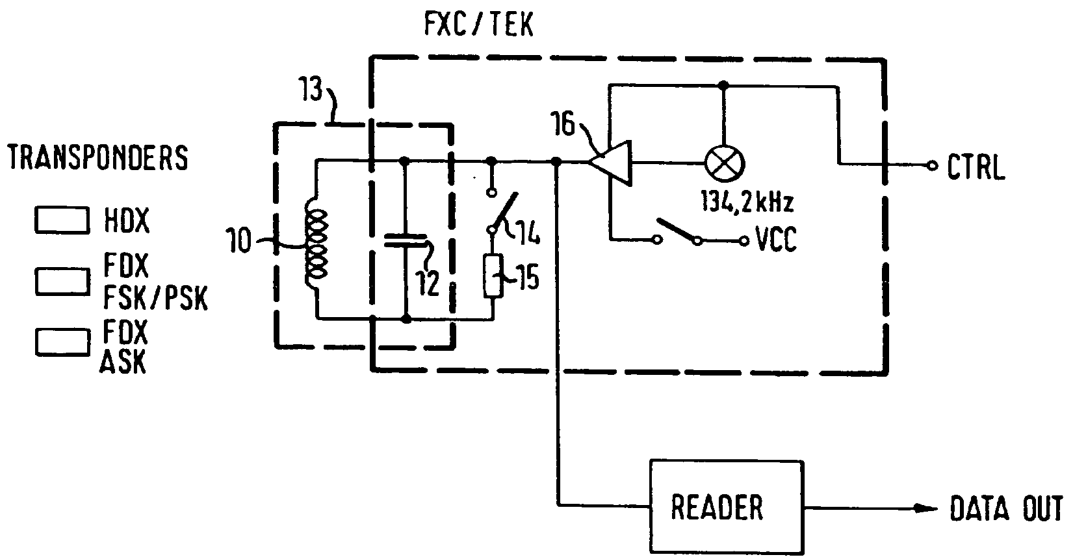
FXC/TEK
13
16
TRANSPONDERS
HDX
FDX
FSK/PSK
FDX
ASK
10
12
14
15
134,2kHz
VCC
CTRL
READER
DATA OUT

Fig. 2

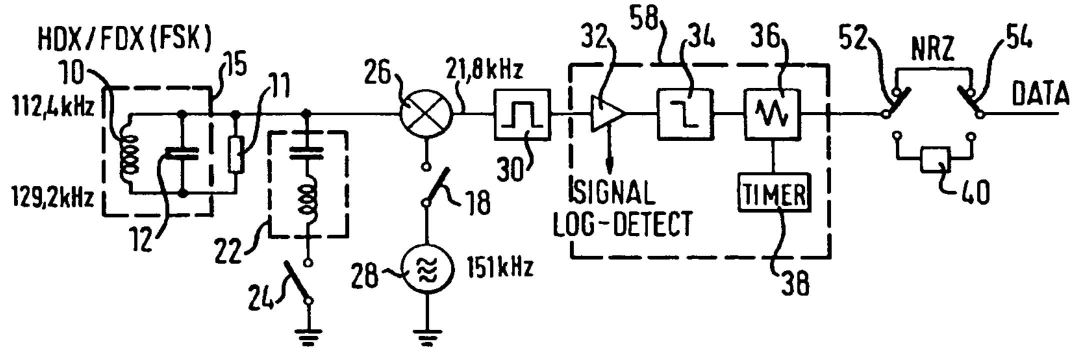

Fig. 2a

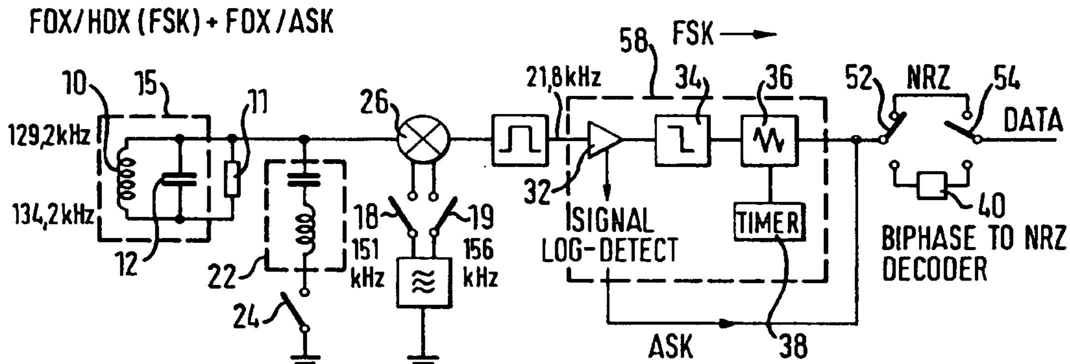

Fig. 2b

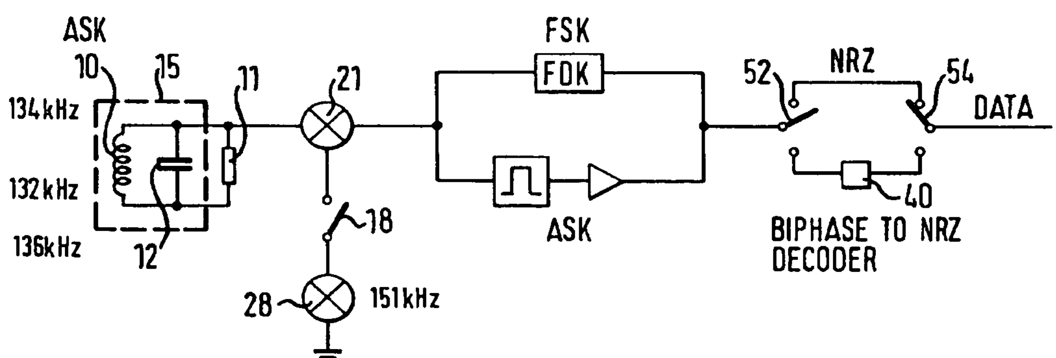

Fig. 3

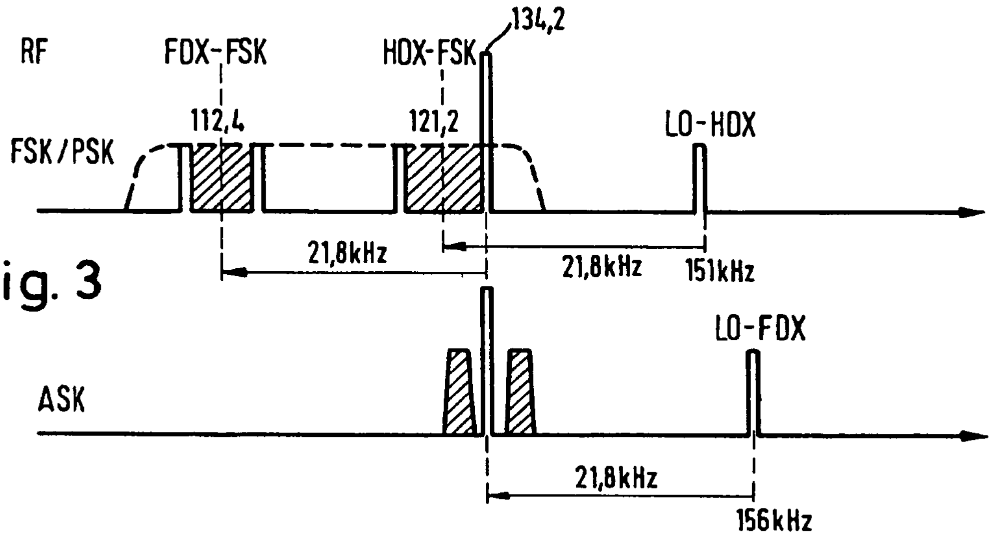

Fig. 4

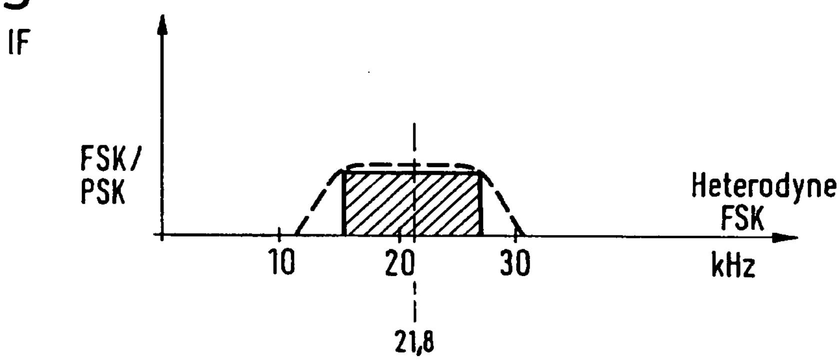

Fig. 5